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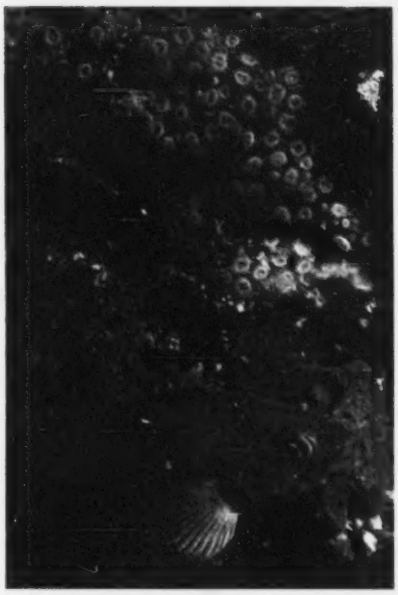
SGAAN KINGHLAS BOWIE SEAMOUNT MARINE PROTECTED AREA MONITORING INDICATORS, PROTOCOLS AND STRATEGIES



Harlequin. Photo Lynn Yamanaka

Figure 1: Sgaan Kinghlas Bowie Seamount Marine Protected Area

Context:

In support of the Health of the Oceans Initiative, Fisheries and Oceans Canada (DFO) Science provides advice on the ecosystem indicators, monitoring protocols and the strategies necessary to evaluate whether the conservation objectives for Marine Protected Areas (MPAs) are being met.

The Sgaan Kinghlas - Bowie Seamount MPA (SK-B MPA) became a Marine Protected Area under the Oceans Act in April 2008. A management plan is currently under development, and DFO Oceans has requested science advice to identify human activities that have the potential to compromise the achievement of the conservation objective. This process will include identifying human activities, their stressors and effects on the marine ecosystem. Along with the identification of stressors, advice was requested to recommend indicators, monitoring protocols and strategies to monitor the impact of the identified stressors on the attainment of the conservation objectives.

The indicators, protocols and strategies identified in this review are not intended to address non-biological (e.g. social or economic) objectives or evaluate compliance with regulations, licenses or other management measures.

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Regional Advisory Process. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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SUMMARY

- The identification of appropriate indicators, monitoring protocols and strategies to assess whether a Marine Protected Area (MPA) is achieving the established conservation and management objectives is a key component of overall MPA management planning and implementation.
- This assessment proposes a five-step framework, based on the Pathways of Effects (PoE) and Ecological Risk Assessment (ERA) methods, for the identification of indicators to monitor the achievement of ecosystem objectives established for any MPA.
- Measurable conservation objectives are required before potential indicators and protocols can be proposed for Sgaan Kinghlas-Bowie Marine Protected Area (SK-B MPA). Further work to develop these is recommended.
- A preliminary PoE analysis was conducted for human activities or "stressors" currently occurring at SK-B MPA. Further work is necessary to finalize these PoE assessments.
- To support the identification of indicators, collection of additional baseline data to complete an Ecological Risk Assessment of the stressors identified for the SK-B MPA and a comprehensive reporting system for existing and proposed activities is recommended.

INTRODUCTION

Rational for Assessment

Marine Protected Areas (MPAs) are designated by DFO under the 1996 *Oceans Act* to conserve biodiversity and ecosystem function of a specific habitat or habitats. Once designated, the conservation objectives for an MPA define the components of the ecosystem that are vulnerable to human activities and that will require monitoring.

Supported by the *Health of the Oceans Initiative*, DFO Science has been asked to provide the following advice respecting the Sgaan Kinghlas - Bowie Seamount (SK-B) Marine Protected Area (MPA):

- Identify human induced threats and associated impacts that have the potential to compromise the achievement of the conservation objectives.
- Evaluate the completeness and appropriateness of the pathway of effects assessments for the MPA.
- Determine whether the potential impacts identified for each threat are adequately covered and whether the assumptions are appropriate and clearly identified.
- Develop recommendations for indicators, monitoring protocols and strategies that are appropriate to evaluate and monitor the achievement of the conservation objectives, the effects of the identified threats, and any actions undertaken to mitigate or eliminate threats.
- Where appropriate, identify any outstanding information gaps and potential approaches to address the gaps.

The indicators herein are not intended to address non-biological or ecological (e.g. social, economic or historical) aspects of monitoring, with the exception of threats as presented by human activities.

Background

To establish meaningful indicators and monitoring protocols, it is imperative that the conservation objectives are measurable, relevant to current policies, and sensitive to meaningful thresholds (Failing and Gregory 2003). Conservation objectives that include targets, time frames and desired probabilities for achieving the targets are desirable to provide variables on which to base meaningful indicators and monitoring protocols.

Where there is an absence of specific objectives, monitoring efforts to evaluate the extent and nature of the effects of human activities can be developed. This work will allow for an evaluation of risk and prioritization of future monitoring and management measures.

This assessment represents the first step in the development of indicators and monitoring protocols for the SK-B MPA. The focus of this assessment was to:

- Conduct a preliminary Pathways of Effects (PoE) evaluation on the human activities that have the potential to stress the ecosystem and identify their likely effects; Develop a framework that will lead to indicator selection in order to monitor the effect of human activities that have the potential to stress the ecosystem for any MPA, and
- Describe current activity-based monitoring programs that are necessary to support the long-term development of a monitoring plan for the SK-B MPA.

Description of the Marine Protected Area

The SK-B MPA is located 180km west of Haida Gwaii (Queen Charlotte Islands). The MPA is 6,000km² in size and its boundary encompasses three seamounts: Bowie, Hodgkins and Davidson (Figure 1). The seamounts are part of the Kodiak-Bowie chain of seamounts found in the North Pacific that extend from the Aleutian Islands to the Bowie seamount west of Haida Gwaii. The seamounts within the SK-B MPA have intricate natural features, including pinnacles, plains and ridges, which create numerous types of habitats. The Bowie seamount is the largest of the three submarine mountains in the MPA and rises from depths of 3,000m to within 24m of the ocean surface. The summit of the Bowie seamount is within the phototrophic zone, creating a unique ecosystem that contains both deep water species such as Prowfish (*Zaprora silenus*) and coastal species such as Harlequin (*Sebastes variegates*) and Yelloweye rockfish (*Sebastes ruberrimus*). The area is rich in species diversity, including SARA listed species such as ancient murrelets (*Synthliboramphus antiquus*), Steller Sea Lion (*Eumetopias jubatas*), Killer Whale, offshore population (*Orcinus orca*) and Bocaccio rockfish (*Sebastes paucispinis*).

Canessa et al. (2003) provides a detailed description of the physical and biological components of the seamount ecosystem, as well as a summary of past human activities in the area, which have included fishing and scientific research. Directed fisheries for halibut *(Hippoglossus stenolepis)*, rockfish *(Sebastes spp.)* and sablefish *(Anoplopoma fimbria)* have taken place in the past and a fishery for sablefish continues to occur. Research activities have included fisheries, geological, oceanographic and ecological studies to gain an understanding of the area's physical components, species richness and oceanographic conditions.

Conservation Objective

The gazetted *Sgaan Kinghlas*-Bowie MPA conservation objective is to:

> *Conserve and protect the biodiversity and biological productivity of the area's marine ecosystem, which includes the Bowie, Hodgkins, and Davidson seamounts and their surrounding waters, seabed and subsoil.*

The conservation objective for SK-B MPA is broad, in part due to the complexity of the seamount ecosystem. At this time, the management plan for the SK-B MPA has not been finalized, and specific measurable objectives have not been defined. These operational objectives will be essential to the development of a science-based monitoring program that will measure ecosystem variables useful and relevant for management of human-induced threats in the area.

Management of the Marine Protected Area

The management plan for SK-B MPA is under development and will elaborate on the regulations for the MPA. It will address matters such as monitoring, enforcement and compliance, and will provide the details required to ensure that the rationale for management decisions, prohibitions, controls and approvals is clearly understood.

For management purposes the MPA is divided into three zones. The photic zone at the peak of the Bowie submarine seamount to the 250 fathom (457m) bathymetric contour is Zone 1. Zone 2 contains the remainder of the Bowie seamount. The Hodgkins and Davidson seamounts comprise Zone 3.

The SK-B MPA regulations state that '*no person shall disturb, damage or destroy, or remove… any living marine organism or any part of its habitat; disturb, damage or destroy or remove… any part of the seabed; or carry out any activity… that is likely to result in the disturbance, damage, destruction or removal of a living marine organism or any part of its habitat,*' with the following exceptions:

- Activities for the purpose of public safety, law enforcement, national security, national defense or emergency response are permitted to ensure the safety of Canadians;
- Fishing by Aboriginal Peoples in accordance with the *Aboriginal Communal Fishing Licenses Regulations* is permitted;
- Scientific research for the conservation, protection and understanding of the area may be approved throughout the MPA under specific conditions;
- Commercial fishing within the MPA (Zone 2) will be allowed as long as this is carried out in accordance with subsection 7(1) of the *Fisheries Act*;
- Given the relative infrequency of its occurrence, recreational fishing will be permitted within the MPA; and
- Travel or transport is permitted pursuant to the *Canada Shipping Act, 2001* and foreign vessel travel pursuant to the *Canada Shipping Act, 2001* and the *Coasting Trade Act*.

Although the regulations allow for activities that are necessary to ensure national security, currently no Canadian Naval or Air Force activities take place in the MPA. The existing sablefish fishery is administered through the Integrated Fisheries Management Plan (IFMP), an annual variation order, and license conditions. The fishery is restricted to Zone 2 of the MPA, permits only one vessel per month (over a six-month period), and allows for the use of trap gear only.

ASSESSMENT

Indicator Identification Framework

The framework developed for the stressor-based identification of indicators to monitor the achievement of the conservation objective includes the following steps, which are further outlined below:

1. Use the pathways of effects (PoE) approach to identify the stressors that result from each activity and their potential effect on the ecosystem.
2. Conduct a risk assessment using an Ecological Risk Analysis Framework (ERAF) on the effects that have been identified though the PoE evaluation.
3. Refine conservation objectives in measurable terms.
4. Identify candidate indicators and protocols to monitor the effect of stressors from activities that have been assessed or prioritized, through the Ecological Risk Analysis Framework, to warrant monitoring (i.e. sufficient risk to achievement of the conservation objectives).
5. Identify candidate indicators and protocols to monitor the ecosystem reference state to serve as baselines for comparison to indicators relevant to stressors.

Pathway of Effects Assessment

Pathways of Effects (PoE) models or diagrams describe the type of cause-effect relationships that are known to exist, and the mechanism by which stressors ultimately lead to effects in the aquatic environment. For each human activity there are known stressors to the environment. The PoE outlines the mechanisms by which human activities may stress the environment and the resulting effects on the ecosystem state. This relationship can be described in the following schematic:

Activity → Stressor → Effect

For each cause-and-effect relationship, a pathway is created by connecting the attributes of the stressor to some ultimate effect on the ecosystem (Boutillier et al. 2010).

Ecological Risk Assessment

An ecological risk assessment is conducted to understand the nature and extent of the effects caused by stressors from a specific activity. Risk to the ecosystem is determined by examining the scale and intensity of negative effects, the sensitivity of species and habitats, and the likelihood of the effect to occur. The level of risk associated with a particular activity can then be ranked according to the expected severity of impact and the probability that an activity will occur. Ranking may be completed using either indices or probabilities. Many different types of Ecological Risk Analysis Framework s exist to address different ecosystems and human activities. DFO has developed an Ecological Risk Analysis Framework for habitat assessment that can be used to understand the impacts of activities within an MPA (DFO 2010b).

Development of Operational Objectives

If conservation objectives established for a particular MPA are not measurable, the identification of the stressors, their effects and the Ecological Risk Analysis Framework can inform the

development of measurable conservation objectives. Conservation objectives thus redefined are often referred to as operational objectives.

Identification of Candidate Indicators

Indicators are used to measure the achievement of a conservation objective, and if used in a structured decision support context, their selection must be guided by suitable criteria (Rice and Rochet 2005). These criteria will assess the quality of the information provided by a candidate indicator. It is essential that the indicators selected describe a property of the ecosystem that can be measured (either directly or indirectly). The candidate indicators should also be sensitive, responsive to change and have specificity to a particular management action. Other criteria to consider in the screening process include the existence of historical data, public awareness, and theoretical basis for use of the particular indicator. Cost is also a consideration when determining whether a specific indicator can be monitored.

Indicators used to support decision making should answer two basic questions: (1) Is the conservation objective being met, and (2) is MPA management consistent with current DFO policies and legislation? These two questions should be expanded to a set of scientifically based questions and testable hypotheses that relate to the specific operational objectives for the MPA, and to the human activities that impact the MPA ecosystem. The questions should be limited to those that can provide managers with information needed for decision-making; otherwise the list of questions (and the indicators needed to answer them) will become long and unrealistic.

Once the key questions for management can be identified, then the selection of potential indicators can begin by examining the information needed to answer the key questions. It is important that indicators inform specific decisions regarding human activities, and provide information on the reference state of the ecosystem. Indicators and protocols to measure the achievement of the conservation objective can be grouped into one of two categories; those that monitor the impact of human activities and those that monitor a reference state.

Identification of Candidate Monitoring Protocols

Different types of monitoring are needed for a Marine Protected Area monitoring program: 1) Activity monitoring to determine the nature and extent of impact from human activities in the area; 2) Compliance monitoring to ensure that regulations and legislation around human activities are being followed; 3) Trend monitoring to track changes in the ecosystem through time; and 4), Effectiveness monitoring to evaluate ability of management actions to meet conservation objectives.

Identification of Potential Stressors for SK-B MPA

The following PoE assessment describes the impacts to the marine environment that are known to result from human activities that currently take place within or near the SK-B MPA. These accounts are descriptions of the potential effects from each activity, not assessments of the actual impacts of these activities. The effects from stressors are assessed related to their potential impact on populations, communities and habitat. It is important to note that not all effects described below are negative, and that further assessments by experts may be necessary to characterize the level of risk to the marine environment from each of the activities described.

Fishing

Fishing in the SK-B MPA area has taken place since the 1980's. Currently, the sablefish trap fishery is the only commercial fishery permitted in the SK-B MPA and only within Zone 2 (Figure 1). The sablefish trap fishery employs a series of conical Korean traps set as a string on a longline that is both anchored to the ocean floor and marked with floats at the surface. Fishing activities are regulated and monitored in accordance with the Integrated Fisheries Management Plan, Groundfish (DFO 2010a). A small amount of recreational fishing by tourists who visit the area may also take place. There is no aboriginal fishing currently occurring at the SK-B MPA; however, the right of the Haida Nation to fish in this MPA for food and ceremonial purposes remains.

Table 1: Pathways of Effects for fishing activities

Activity	Stressor	Effect
Fishing	Removals of target & non-targeted species	Loss of biodiversity
		Trophic effect from the reduction of populations (predator and/or prey) that cascade through the ecosystem
	Discards of target & non-target species	Increase nutrients to the ecosystem
	Habitat damage	Loss of biodiversity from direct effects (mortality)
		Indirect effects on biodiversity from habitat disturbance (destruction of biogenic species that create complex habitat, sedimentation events)

Vessel Traffic

Vessel traffic in the area consists of tankers transporting crude oil from the terminus of the Trans Alaskan Pipeline System (TAPS) in Valdez, AK to ports along the US west coast, and tankers shipping commercial products across the North Pacific. Other vessel traffic in the area includes fishing vessels, tourism activities and research vessels. In order to reduce the risk of an oil spill along the coast, a voluntary Tanker Exclusion Zone (TEZ) has been established 100 miles offshore of Haida Gwaii (Canadian Coast Guard 1998; Canessa et al. 2003). The boundary line was designated to prevent a disabled tanker from drifting ashore prior to the arrival of salvage tugs. However, the SK-B MPA is west of the TEZ boundary, and is therefore susceptible to oil tanker traffic. Groundings on the shallow Bowie seamount and collisions of ocean-going vessels are also a risk to the area.

Table 2: Pathways of Effects for vessel traffic

Activity	Stressor	Effect
Vessel Traffic	Contamination introduction	Alteration of habitat
	Tanker oil spill	Loss of biodiversity
		Alteration of habitat
		Alteration of reproductive & developmental potential of populations
	Debris, garbage & loss of cargo	Alteration of habitat
	Waste water	Alteration of habitat
	Exotic species introduction	Reduction of available habitat
		Loss of biodiversity
		Alteration of ecosystem function/structure
	Groundings	Alteration of habitat
	Light	Harassment of species (seabirds)
	Noise	Harassment of species (marine mammals)
	Vessel strikes	Removal of individuals (marine mammals)
	Anchoring	Alteration of habitat

Tourism

The stressors and effects from tourism activities that are due to vessel traffic or fishing activities are covered in the previous paragraphs. The remaining aspect of tourism activity occurring in SK-B MPA is recreational scuba diving. Divers are attracted to the site because of the abundant marine life and submarine features, but may disturb benthic habitats, while obtaining buoyancy control or by touching the sea floor, while moving through the water, and by picking up invertebrates to examine them.

Table 3: Pathways of Effects for tourism activities

Activity	Stressor	Effect
Tourism	Light	Harassment of species (benthic)
	Physical disturbance	Harassment of species (benthic)
		Alteration of habitat

Scientific Research and Monitoring

Some scientific research, focused on geology, ecology, oceanography, and fisheries research, to investigate the potential of rockfish and sablefish fisheries has occurred in the past in SK-B MPA. Previous data collection methods at Bowie have included measurements of the physical

and chemical characteristics along the seabed, capturing video footage from a submersible vehicle, and exploratory fishing (trawl, hook and line, trap and jig). All research in the area is conducted under scientific license. Depending on the type of research conducted, the activities may produce stressors similar to fishing activities and vessel traffic, which are described above.

Table 4: Pathways of Effects for scientific research and monitoring activities

Activity	Stressor	Effect
Scientific research & monitoring	Removals of target & non-target species	Loss of biodiversity
		Trophic effect from the reduction of populations (predator &/or prey) that cascade through the ecosystem
	Discards of target & non-target species	Increase nutrients to the ecosystem
	Habitat damage	Loss of biodiversity
		Indirect effects on biodiversity from the destruction of biogenic species that create complex habitat
	Light	Harassment of species (benthic)
	Physical disturbance	Harassment of species (benthic)
		Alteration of habitat

Selection of Indicators for Sgaan Kinghlas-Bowie MPA

The selection of appropriate and meaningful indicators for SK-B MPA is not possible until the measurable operational objectives are clarified.

Monitoring Protocols for Sgaan Kinghlas-Bowie MPA

The final selection of monitoring protocols cannot be completed until specific indicators are selected. However, in the interim, collection of information to inform the Ecological Risk Analysis Framework evaluation, support risk ranking, and conduct baseline monitoring will support the development and ultimately the evaluation of the conservation objectives.

Currently the seamount sablefish fishery that takes place at Bowie seamount is monitored through catch logbook data, at-sea observers, on board electronic monitoring, port-sampling, and dockside monitoring. Compliance monitoring to verify that fishers meet conditions of licence, record fishing effort and verify catch is also conducted. The requirement for and opportunities to collect additional biological information should be assessed.

Transport Canada monitors ballast water exchange of ocean-going vessels through the Canadian Ballast Water Program. Activity monitoring of oil spills and other pollutants is completed by Transport Canada through the National Aerial Surveillance Program (NASP). Environment Canada also monitors oil spills and other ocean surface anomalies through the Integrated Satellite Tracking of Polluters Transitioning to an Integrated Production Environment

(ISTOP) program which uses satellite imagery. An assessment to determine whether the information from these monitoring programs is sufficient should be completed to ensure that both the nature and the extent of this activity are understood.

DFO participation in other programs that track the status of oceanographic conditions in the North Pacific is summarized in the annual State of the Oceans Report (http://www.pac.dfo-mpo.gc.ca/science/psarc-ceesp/osrs/index-eng.htm). It should be noted that this summary provides a snap-shot for conditions over the previous year, and is not a synthesis of a multi-year data set. This work is designed to document the state of the North Pacific Ocean and may present results at too coarse a scale for the SK-B MPA monitoring.

Previous data collection efforts have focused on fisheries, geological, oceanographic and ecological studies to understand the area's physical components, species richness and oceanographic conditions. An evaluation of current data holdings and monitoring protocols needs to be completed before any of the above data sets and associated methodologies are incorporated into a monitoring program.

Strategies for Monitoring

DFO is responsible for the coordination of science monitoring in the MPA. However, a collaborative effort involving a variety of organizations and research groups will be necessary to successfully monitor this remote seamount. Furthermore, it is a key objective of the Canada Federal Marine Protected Areas Strategy to enhance collaboration for management and monitoring of marine protected areas (DFO 2005). Data gathered from vessels or aircraft of opportunity, fixed station monitoring, and remote sensing should be used whenever possible. Coordination of MPA monitoring with existing departmental monitoring strategies (i.e. fisheries management, marine mammal monitoring) is needed for efficient and cost-effective monitoring.

Regardless of the strategies used, planning for long-term monitoring activities is crucial for the development of a long-term data set and the ultimate success of a monitoring program. Although collaborations are critical for monitoring this MPA, a dedicated sampling program may be necessary to ensure all proposed monitoring activities are completed. Collaboration between DFO sectors will be necessary for effective monitoring and subsequent management.

To determine the nature and effects that human activities have on the achievement of the broader conservation objective, a comprehensive reporting system is required that captures existing and proposed activities at SK-B MPA. Currently, reporting of some activities takes place using cruise logbooks and scientific licences.
Development of a data management system is an integral component to a monitoring program, as it will ensure data integrity and access. Data management will be necessary to compile historic information, for completing risk assessments, and for current and future monitoring activities.

Sources of Uncertainty

Several knowledge gaps exist that will require research or data collection in order to identify indicators and develop a monitoring program. There are information gaps regarding the frequency of human activities in the MPA, as well as uncertainties regarding the nature and extent of the stressors and their effects. The ability to complete the steps in the indicator identification framework will be dependent on the data available.

There are sources of uncertainty regarding the ecosystem structure and function that will continue to exist, regardless of how extensive and thorough a monitoring program becomes. Regime shifts due to large global processes such as the Pacific decadal oscillation (PDO), El Niño, and climate change may have unanticipated results on the MPA ecosystem. These large scale stressors or ecosystem drivers are not within the scope of management, but will need to be taken into consideration and may require indicators and monitoring. Cumulative impacts also need to be acknowledged when assessing whether the conservation objective(s) have been achieved, or when developing management measures.

CONCLUSIONS AND RECOMMENDATIONS

The identification of meaningful indicators, monitoring protocols and strategies to assess whether an MPA is achieving the established conservation and management objectives is a key component of overall management planning and implementation. Measurable conservation objectives for SK-B MPA are necessary before appropriate indicators and monitoring protocols can be recommended.

A five-step stressor-based Indicator Identification Framework, based on the Pathways of Effects (PoE) and Ecological Risk Assessment methods, for the identification of indicators to monitor the achievement of ecosystem objectives established for any MPA was developed and endorsed. A preliminary PoE assessment was conducted for human activities currently occurring at SK-B MPA to inform decisions about what data and sampling is necessary to complete the remaining steps in the framework. A more thorough evaluation of the stressors to this MPA needs to be completed before the risk assessment step can be undertaken. This evaluation, combined with measurable conservation objectives, will facilitate the identification of indicators, monitoring protocols and strategies for SK-B MPA.

Recommendations & Next Steps:

1. Develop measurable conservation objectives (sometimes referred to as operational objectives) for SK-B MPA.
2. Building on previous studies that are summarized in Canessa et al. (2003), collect baseline data that completes the Ecological Risk Analysis of identified stressors for the SK-B MPA.
3. Implement a comprehensive reporting system for existing and proposed activities in SK-B MPA, to determine the nature and effect of human activities.
4. Utilize the stressor-based indicator identification framework to identify appropriate indicators for monitoring the achievement of the SK-B MPA objectives.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory meeting of October 26–28, 2010 on Pacific Review of Bowie Marine Protected Area (MPA) monitoring protocols, Pacific Review of Endeavour Ridge Area monitoring protocols. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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FOR MORE INFORMATION

Contact: Miriam O
Institute of Ocean Sciences
9860 West Saanich Road
Sidney, British Columbia
V8L 4B2
Tel: 250-363-6618
Fax: 250-363-6323
E-Mail: Miriam.O@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: 250-756-7208
Fax: 250-756-7209
E-Mail: CSAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs

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